MEMORANDUM

TO: Office of Grants and Research Contracts
ATTENTION: Miss Winnie M. Morgan

FROM: H. A. Tyroler, M.D.
Professor, Department of Epidemiology

DATE: August 24, 1967

SUBJECT: Progress Report NGR-34-003-021, January 1, 1967 through July 30, 1967.

Continuing progress has been made in fulfilling the aims of this project as described in the original application for the research grant, and as expanded and modified in the request for supplement number two. In addition to the concepts and methods developed for an automated medical records system, as documented in prior publications and progress reports, plans have been drawn for implementation of collaborative studies at Huntsville. These will focus on evaluation of periodic health examinations, the occupational typologies, and the relationship between the two. Dr. Cardillo has initiated both a screening and comprehensive examination program; his immediate goal is the evaluation of the relative value of the components of the examination; our collaborative long range interest will be in the linkage of medical, personnel and environmental health data in an occupational surveillance and epidemiologic information system. Plans for these activities are described in the attached research memoranda.

cc: George R. Holcomb, Dean
Office of Research Administration

M E M O R A N D U M

TO: L. Arnoldi, M.D.
J. Cassel, M D.
T. Cardillo, M.D.
R. Carter, M.D.

FROM: H. Tyroler, M.D.

DATE: June 19, 1967

SUBJECT: Proposed studies for Grant NGR 34-003-021, Supplement No. 2.

A meeting of the above listed individuals was held on June 15, 1967, at the Department of Epidemiology, University of North Carolina. This memorandum is an attempt to summarize our deliberations and set out a series of explicit goals and activities agreed upon at the meeting. A tentative series of time schedules has been added.

The representatives of both the NASA Division of Occupational Medicine and the University of North Carolina were in agreement that our collective needs could best be served by organizing our joint medical program, teaching and research activities around the following four subject areas as outlined by Dr. Cassel:

1. What is the current health status of the employees of NASA, and what time trends are discernible?

2. What evidence is there that current medical attempts are influencing health status, which activities are successful and which require modification or supplementation?

3. What information can we collect to learn more about the determinants of ill health of NASA employees?

4. What activities can be initiated with currently available

methods and technology to provide a real time, usable, centralized medical intelligence network--i.e. an epidemiologic surveillance system--?

It was agreed that initial explorations would proceed with analyses of data collected at Marshall Space Flight Center. Dr. Arnoldi expanded the four areas as listed above to include comprehensive profiles of occupational medical requirements, working force attributes and rates of change over time. He felt that pilot studies at Huntsville could provide an opportunity to test prototype models for future use at all NASA centers.

Dr. Cardillo described his current attempts at screening examinations, as a guide to setting time priorities for physical examinations. He expressed a need for statistical, epidemiologic, and data processing consultation for definitive analysis of his now considerable clinical experience. It was agreed that Dr. Carter would visit on-site at Huntsville to familiarize himself with procedures used and to "immerse himself in the medical data" requirements of Dr. Cardillo. It is important to point out here that any such consultations or analyses by the UNC team of Huntsville data would neither violate the confidentiality of the medical information nor compete with the professional and scientific uses of the data as collected by the MSFC group. In a very real and important sense the information belongs to Dr. Cardillo until he releases it (which we hope he will wish to do in the future for additional collaborative teaching and research proposes).

The next priority, after evaluation of the screening program, is that of converting the medical examination data to a form suitable for automated data processing. Dr. Carter will investigate the problems of codification, and Dr. Cardillo will decide whether or not to have key

punching done at Huntsville. If it were done at UNC, the entire volumn of medical records (approximately 5,000 examinations) could be ready approximately two weeks after encoding.

Data processing, consisting of tabulations and analyses, then could proceed sequentially with collaborative conferences as each phase was completed and next steps programmed. It would be wise to have these conferences on an on-call basis as the work progressed; however, Dr. Carter will keep all participants updated on the program, and I would recommend a conference and progress report at least once a month.

I would list for your reactions the following analyses, which could begin immediately. the examination data is on punch cards:

1. Set up a record linkage mechanism tying the examination data on each individual to the personnel data by use of a coded, anonymous, but unique and retrievable identification number. This would permit us immediately to generate:

   a. The personal, occupational and work environmental profiles of all examinees.

   b. The profiles of all non-participants in the examination program. Dr. Cardillo had the impressive, voluntary participation rate of 70% in his examinations; however, it is important to find out if there are any systematic differences in the personal and work characteristics of those electing not to participate.

   c. The relationships, if any between personal, occupational, work characteristics and the findings on Dr. Cardillo's examinations.

2. Set up a program of statistical descriptors of a detailed nature, fully to analyze the medical examination program. This would

permit us to:

a. Rapidly and mechanically generate full frequency distributions, graphic representations, and summary statistics for each procedure used in the examination battery.

b. Study the interrelations among the variables analyzed and identify clusters of abnormalities. The prototype of this, of course, is the coronary risk profile with abnormal ECG, hypertension, hypercholesterolemia, etc. Many other such clusters exist and can be tested. I would suggest that this testing proceed in a systematic fashion with statistical probes initiated by Dr. Cardillo's clinical "hunches".

c. In a manor analogous to the physico chemical risk factors, attempt to identify clusters of personal, occupational and work environmental attributes related to both illness and illness behavior. The latter, as reflected in medical department utilization and illness absenteeism, may be most important. This can be explored by a questioning dialogue between Dr. Arnoldi and the Medical Data Bank, collated from all relevant NASA information sources, and accessible for computerized information retrieval and analysis.

Most of the activities listed above are currently feasible and require little if any research. The problems we can anticipate in implementation will be mechanical and procedural. However, to get maximal benefit from our collaborative efforts, I strongly urge that we set up meetings of two types, in addition to those necessary for achieving the specific goals itemized above. The first type would be that directed

towards hypothesis generation and testing. As the program data emerges, we should ask what it means and how we can go about refining our future study of the possible explanations of collective interest to us. The second type of meeting should be that of sharing the results of this work with professional colleagues, medical and graduate students. I would recommend seminars with other NASA physicians to interest and motivate them; with UNC professionals to get their expert constructive criticisms; with graduate students to give them the benefits of our work. The latter, teaching effort, will also stimulate us to do our best. Nothing forces learning and clarification so strongly as does trying to teach someone else.

I await your reactions to these proposals and the specific steps necessary to initiate our collaborative work.

MEMORANDUM

TO: Dr. Cardillo
Dr. Frierson
Dr. Courly
Dr. Spraul

FROM: Dr. Carter

DATE: July 24, 1967

RE: Evaluation of Huntsville trip.

Objectives

A. Complete a random sample of employees who appeared to be normal with respect to the current multiphasic screening program at Huntsville in order to facilitate evaluation of the program.

B. Review encoding problems of data presently collected by Huntsville medical facility for purposes of automatic data processing.

C. Observe the screening program at Huntsville medical facility for purposes of familiarization.

D. Interview medical staff in order to ascertain present problems and future interests with respect to consultation with UNC Department of Epidemiology.

Results

A. A random sample of all employees who had been found normal with respect to the screening program was accomplished in the following manner. The summary cards of all employees at risk were numbered consecutively (0-2449). Then the RAND book of random numbers was entered in the manner prescribed in this book. Initially 600 numbers were selected and the summary cards whose numbers corresponded to the

list were drawn from the summary card file. If a number had been listed twice the second attempt to draw that card would fail and another random number, the next one from the table, was added to the list. The process was continued until 600 cards had been drawn. However, after this sample had been drawn a problem of mutual concern and interest required an additional sampling procedure. In the original screening program one group of individuals had been screened with a, employee written, history form and another group without such a history form available to the physician who decided the screening test showed an abnormality. Thus it was felt that the medical staff should have the option of comparing the results of the screening program with respect to the presence or absence of a history form.

From the original sample calculated with 95% confidence to have a P interval of less than 3% about an estimated P of 20%, 65 (10.8%) of the 600 employees drawn at random were found to have been examined without histories. It is difficult to estimate the number of employees without histories in the 2450 employees but given the 10.8% found on the random sample the P interval would be about 2% with 95% confidence (a 20 to 1 chance) that the number of employees without histories would be 265 with a range of 216 to 314. Choosing an estimated P of 50% with a P interval of 5% at a 95% level of confidence for an estimate of 314 employees, the sample size calculates out to 175. Since 314 was the outside estimate of the number of employees without histories, we elected to draw only 100 more employees without history

forms from the remaining 1850 summary cards. Thus a new list of numbers between 0 and 2449 will be drawn from the random table at the point where the initial 600 sample stopped. Of the cards chosen the corresponding charts will be inspected and only those charts containing no history will be accepted. This will be done until 100 additional employees are selected who did not have a history. The employee ID numbers of these additional 100 will be listed so that they can be readily separated when analyzing the total validity of the screening program. When the comparison is made, the employees will be divided according to presence or absence of histories, thus 535 will have histories and 165 will not have histories. Finally, the additional 100 cards should be shuffled with the initial 600 so that the medical staff is blind to which groups they are evaluating.

If the sampling is carried out in this manner the medical staff can then answer the following questions: (screening program validation).

1. What is the ability of the screening program to detect abnormalities in employees (sensitivity of program)?

2. What is the ability of this screening program to detect non-abnormalities in employees (specificity of program)? Furthermore, these questions cannot only be answered for the total screening program using estimates based on the initial 600 employees but also a comparison can be made between the screening program before and after history forms were discontinued. This comparison could be of real importance in determining the value of history forms within a multiphasic screening program.

In order to make valid comparisons between normal and abnormal screened employees three rules were agreed upon.

1. If the examining physician is certain that any abnormality he discovers on examination occurred after the time of screening this abnormality will not be counted as an abnormal finding for the purposes of this study.

2. The examining physician will utilize the original history and lab data only in designating those employees who were screened as negative but actually had detectable abnormalities.

3. The examining physician will be kept blind to any initial validity calculations.

B. The encoding problems are under study at this time. On the positive side, the lab data is currently being encoded on forms (see APPENDIX 1) for the purpose of factor or discriminant function analysis by the prime employer of the medical staff (Aerojet General) copies of these coding forms are being made and probably could be utilized. On the negative side are these factors:

1. Codes must be abstracted from the medical chart in a cumbersome manner i.e. a search of all screening forms in the chart.

2. With unsystematic exceptions data on morbidity and mortality is not currently retrievable from medical forms or the master file of personnel records which UNC Department of Epidemiology has access to.

4. None of the history is being encoded presently.

5. There are two or three history forms and while each is encodable it may be difficult to devise a code which will include all forms.

If information is to be encoded on history, physical, and lab information, we should probably design a general single summary form which can be filled out by the MD at exam time, routed through a clerk for encoding and returned to the medical chart. The coded forms can then be punched and forwarded to the location of the employee health file for record linkage and/or data processing. A general open form like that used in the Malawi Public Health Program could be used. Another open form could be that of a dual purpose McBee card. One purpose would be as a summary form from which data could be encoded and then the coded forms routed to the envisioned automated data file and subsequent NASA wide data processing. The second purpose would be as a easy means of local recordkeeping and limited manual data processing in order to satisfy local interests and problems. The very real problem of physician time and standardization in filling out any summarization form must be considered before their design or implementation. However, the recent and present problems of retrieving scattered data from medical charts could have been overcome to a great extent had there been a single form to manipulate, e.g. counting, sorting.

C. The screening program appears to be very efficient; however, in order to estimate the payoff or the various screening tests with respect to the amount of medical staff time required some measurements of the time at each station and the total time could be made. Also it is not clear from the charts which particular screening activity resulted in calling an employee back for an examination. Thus it is difficult to estimate the payoff of the various tests with respect to detecting abnormal health states.

The rest of the medical facility was toured and I was especially interested in the possibilities inherent in the mobile electrocardiograph unit for a systematic definition or cardiac dynamic states in and between selected groups of employees. The ability to reduce the data at 60 times its collection rate is impressive.

For example, recent studies have suggested that individuals employed in "interface" or "boundry" positions are at higher risk to disease states than their fellow employees. Such individuals may be salesmen, formen, or quality control engineers. These positions seem to require an individual to assume different roles depending upon the quality and quantity of groups the individual interacts with. It might be interesting to select some individuals from "interface" groups and "non-interface" groups and monitor these individuals. One could then not only compare the different members of each group but also compare the minotored data as the "interface" individuals react to the demands of different roles and environments. It may be that we could determine which kinds of roles and environments resulted in different EKG. patterns. Some of which may be either abnormal patterns or predictive of future abnormal patterns.

D. The major current problems of the medical staff seem to be:

1. The effects of not using history forms.

2. What to do following the completion of the current screening program.

The study as suggested above, i.e. comparing the validity of the screening program with and without history forms, may suggest the value of the history in quantitative terms either negative or positive.

What to do next depends upon the interests of the medical staff. Hopefully, we can use the data gathered to estimate "What is the current health status of the employees of NASA, and what time trends are discernable?", the first objective agreed upon at the June meeting in Chapel Hill. This objective has certain implications which appear to fit the current interests of the medical staff:

1. Evaluation of the existing screening tests.

2. Development and evaluation of new screening tests.

3. Determination of priority disease states.

4. Longitudinal studies to assess time trends.

5. Introduction of random sampling techniques in order to reduce work load and to obtain reliable estimates of existing health states.

6. Record keeping and data processing.

The major current interests of the medical staff appear to be:

1. Evaluation of the screening program in terms of its effect on the employees with abnormalities.

2. Stress research; chronic and acute.

3. Rehabilitation research; psychological and physical.

The staff are now calling back all employees with newly detected abnormalities and determining if a local physician was seen and if so what the current status of the abnormality is.

Stress research interests focused on cardiac (EKG) and steriod monitoring tests for detection of chronic illnesses and on EKG monitoring in acute situations (underwater work, countdown, etc.).

Rehabilitation research interests centered on physical reconditioning of the cardiovascular system, and the vertebral musculoskeletal system. Also interest was expressed in the effects of early return to partial work status versus waiting for complete physical recovery and abrupt return to full work status.

In conclusion it is hoped this report will be of some value in stimulating discussion at our forthcoming conference in Chapel Hill.

Richard A. Carter, M.D.

Richard A. Carter, M.D.

cc: Dr. Arnoldi
√Dr. Tyroler
Dr. Cassel

MSFC MEDICAL FACILITY
MULTIPLE FUNCTION ANALYSIS OF CLINICAL SCREENING DATA
CODING SHEET

Sheet 1

	PHYSICAL CHARACTERISTICS						HEMATOLOGY													BLOOD CHEMISTRY				URINALYSIS														
IDENT. NO.	SEX	HEIGHT	WEIGHT	PULSE	B.P. SYSTOLIC	B.P. DIASTOLIC	HGB	HCT	WBC	SEGS	BANDS	LYMPHS	MONO	EOSIN	BASO	MYELO	BLASTS	SED RATE	SEROLOGY	BUN	GLUCOSE	CHOLESTEROL	URIC ACID	REACTION	SP GRAV.	ALBUMIN	SUGAR	ACETONE	BILE	RBC	WBC	HYALINE CASTS	FINE GRAN. CASTS	COARSE GRAN. CASTS	RBC CASTS	WBC CASTS	FATTY CASTS	
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MSFC MEDICAL FACILITY
MULTIPLE FUNCTION ANALYSIS OF CLINICAL SCREENING DATA
CODING SHEET

Sheet 2

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